

the Foraminiferal shells whose internal casts formed the Greensand deposit of the Cretaceous epoch, must remain for the present an open question\*.

II. "Report to the Hydrographer of the Admiralty on the Cruise of H.M.S. 'Challenger' from July to November 1874." By Prof. WYVILLE THOMSON, F.R.S., Director of the Civilian Scientific Staff on Board. Received January 4, 1875. (Published by permission of the Lords of the Admiralty.)

H.M.S. 'Challenger,' Hong Kong.

The 'Challenger' left Port Nicholson on the 7th of July, 1874, and proceeded under sail along the east coast of New Zealand. On the 8th we rounded and trawled in 1100 fathoms, lat.  $40^{\circ} 13' S.$ , long.  $177^{\circ} 43' E.$ , with a bottom-temperature of  $2^{\circ} C.$  and a bottom of soft greenish ooze. Many animals were brought up by this trawl resembling closely those which we had taken at a corresponding depth in other portions of the southern sea. On the 10th we again trawled and sounded in 700 fathoms about 40 miles to the east of East Cape.

We then continued our course northwards towards the Kermadec Islands, and on the 14th we took our usual series of observations midway between Macauley and Raoul Islands in the Kermadec group. At this station we trawled at a depth of 630 fathoms; and we were greatly struck with the general resemblance between the assemblage of animal forms brought up in the trawl and the results of a good haul in about the same depth off the coast of Portugal or North Africa. Among the more interesting objects were a very large and splendid specimen of a Hexactinellid sponge allied to *Poliopogon*, several other fine sponges referred to the same group, and three or four examples of two species of *Pentacrinus* new to science, resembling generally *P. asteria*, L., from the Antilles. We trawled on the following day in 600 fathoms, 45 miles to the north of Raoul Island, with nearly equal success. On the evening of Sunday the 19th we arrived at Tongatabu and called on the principal missionary, Mr. Baker, from whom we received every possible attention during our short stay. After spending two days in visiting different parts of the island, we left Tongatabu on the 22nd of July, and after taking a few hauls of the dredge in shallow water we proceeded towards Kandavu in the Fijis. On the 24th we stopped off Matuku Island and landed a party of surveyors and naturalists; and while they were taking

\* It is due to Prof. W. C. Williamson to point out that, in the Memoir already referred to, he indicated the probability "that many of our European Greensands, and other siliceous strata, however barren of such structures they appear, may have once contained multitudes of calcareous microscopic organisms, some of which have been removed *after* the consolidation of the strata, leaving either hollow casts, or having had the cavities subsequently filled with silica."

observations and exploring on shore we trawled in 300 fathoms, and procured among other things a fine specimen of the Pearly Nautilus (*Nautilus pompilius*), which we kept living in a tub for some time in order to observe its movements and attitudes.

On Saturday, the 25th of July, we arrived at Kandavu, on the 28th we went to Levuka, and on the 3rd of August we returned to Kandavu, where we remained until the 10th.

At Fiji the civilian staff were occupied in examining the reefs and generally in observing the natural history of the islands; and in this we received all friendly assistance from H.M. Consul Mr. Layard and from Mr. Thurston, minister of King Cacobau. During our stay, a mixed party of naval and civilian officers went in the ship's barge to Mbaw and visited the king.

Between New Zealand and the Fiji group only two soundings were taken to a greater depth than 1000 fathoms. Of these, one, at a depth of 1100 fathoms off Cape Turnagain, New Zealand, gave a bottom of grey ooze and a bottom-temperature of  $2^{\circ}$  C.; and the second, at 2900 fathoms, lat.  $25^{\circ} 5' S.$ , long.  $172^{\circ} 56' W.$ , midway between the Kermadecs and the Friendly Islands, gave "red clay" and a temperature of  $0^{\circ} 5$  C. Four serial temperature-soundings were taken; and the distribution of temperature was found to correspond, in its main features, with what we had previously met with in oceans communicating freely with the Antarctic sea.

The dredgings, which, with the exception of one near the New-Zealand coast, were all at depths varying from 300 to 600 fathoms, yielded a great number of very interesting forms; but, as I have already remarked, they tended to confirm our impression that, even at these comparatively moderate depths (at all depths, in fact, much greater than a hundred fathoms), while species differ in different localities, and different generic types are from time to time introduced, the general character of the fauna is everywhere very much the same.

On the 10th of August we left Kandavu and proceeded towards Api, one of the least known of the New Hebrides, where there is as yet no permanent missionary station. On the 12th we sounded and trawled in 1350 fathoms, with a bottom of reddish ooze; we sounded again on the 15th in 1450 fathoms, with red clay; and on the 18th, after passing through the channel between Makuru and Two-Hill Islands, we stopped off Api in 25 fathoms, close to the edge of the reef and opposite a landing-place.

In order to ensure, as far as we could, the good-will of the natives, Captain Nares had given a passage to eleven Api men, who had been employed for a three-years' term in Fiji, under the arrangement which exists there for the regulation of Polynesian labour. Two or three of us, with an armed party, took the returned labourers ashore; and as the natives (although they appeared somewhat mistrustful and were all armed

with clubs, spears, and bows with sheaves of poisoned arrows) were sufficiently friendly, nearly all the officers landed and spent a few hours rambling about the shore. It was not thought prudent to go far into the forest, which was very dense and luxuriant and came close down to the beach.

The natives were almost entirely naked, and certainly bore a very savage and forbidding aspect. One of them was manifestly greatly superior to the others, and appeared to exercise a considerable influence over them. He wore trowsers and a shirt and a felt hat, and could speak English fairly. He recognized me, at once, as having seen me at the sugar-plantation in Queensland, where he had been for the usual three-years' engagement, and showed me, with great pride, a note from his former employer, saying that the bearer was anxious to return to his service, and that he would willingly pay his passage-money and all expenses, in case of his being given a passage to Brisbane. I had been paying some attention to the South-Sea labour question, and had formed a very strong opinion of the value to the inhabitants of these islands of the opportunity given them, by this demand for labour, of testing their capacity to enter into and mix with the general current of working men, and thereby possibly avoid extermination; and I was greatly pleased to see the result in this instance.

From the island of Api we shaped our course to the north-westward towards Raine Island, in a breach of the great barrier reef not far from the entrance of Torres Strait. On the 19th of August we sounded, lat.  $16^{\circ} 47' S.$ , long.  $165^{\circ} 20' E.$ , at a depth of 2650 fathoms, with a bottom of "red clay" and a bottom-temperature of  $1^{\circ} 7 C.$  ( $35^{\circ} F.$ ). A serial temperature-sounding was taken to the depth of 1500 fathoms; and it was found that the minimum temperature ( $1^{\circ} 7 C.$ ) was reached at a depth of 1300 fathoms, and that consequently a stratum of water at that uniform temperature extended from that depth to the bottom.

Serial temperature-soundings were taken on the 21st, the 24th, the 25th, the 27th, and the 28th of August in 2325, 2450, 2440, 2275, and 1700 fathoms respectively; and in each case the minimum temperature of  $1^{\circ} 7 C.$  (or a temperature so near it as to leave the difference within the limit of instrumental or personal error of observation) extended in a uniform layer, averaging 7000 feet in thickness, from the depth of 1300 fathoms to the bottom.

It will be seen by reference to the chart that on our course from Api to Raine Island we traversed for a distance of 1400 miles a sea included within a broken barrier, consisting of the continent of Australia to the west, the Louisiade archipelago, the Solomon Islands, and a small part of New Guinea to the north, the New Hebrides to the east, and New Caledonia and the line of shoals and reefs which connect that island with Australia to the south. The obvious explanation of this peculiar distribution of temperatures within this area, which we have called, for

convenience of reference, the "Melanesian Sea," is that there is no free communication between this sea and the outer ocean to a greater depth than 1300 fathoms, the encircling barrier being complete up to that point.

The "Melanesian Sea" is in the belt of the S.E. trade-winds, and the general course of a drift-current which traverses its long axis, at an average rate of half a knot an hour, is to the westward; evaporation is, as it is usually throughout the course of the trade-winds, greatly in excess of precipitation, so that a large amount of the surface-water is removed. This must, of course, be replaced, and it is so by an indraught of ocean-water over the lowest part of the barrier, at the proper temperature for that depth. We had previously found a temperature of  $1^{\circ}7$  C. at a depth of 1300 fathoms on the 16th, the 19th, and the 21st of June between Australia and New Zealand, on the 17th of July in lat.  $25^{\circ} 5'$  S., long.  $172^{\circ} 56'$  W., and earlier on the 10th of March in lat.  $47^{\circ} 25'$  S. The bottom within the Melanesian Sea may be described generally as "red clay," with a small but varying proportion of the shells of Foraminifera, sometimes whole, but more usually much broken up and decomposed. In one or two soundings the tube showed curiously interstratified deposits, differing markedly in colour and in composition. The trawl was sent down on the 25th of August to a depth of 2440 fathoms. The animals procured were few in number—some spicules of *Hyalonema*, a dead example of *Fungia symmetrica*, two living specimens of a species of *Umbellularia* (which appears to differ in some respects from the Atlantic form), and a very fine and perfect *Brisinga*, also living. The existence of animal life is therefore not impossible in the still bottom-water of such an enclosed sea; but, as we have already seen in the Mediterranean, the conditions do not appear to be favourable to its development. On the 29th of August we trawled in 1400 fathoms, about 75 miles to the east of Raine Island, with somewhat greater success. This might have been anticipated, as the depth was not much greater than that at which the free interchange of water was taking place, and diffusion and intermixture were no doubt much more rapid than at the bottom.

On the 31st of August we visited Raine Island, which we found to correspond in every respect to Jukes's description in the "Voyage of the 'Fly.'" We observed and collected the species of birds which were breeding there. In the afternoon we dredged off the island in 155 fathoms, with small success, and proceeded towards Port Albany, Cape York, where we arrived on the 1st of September.

We left Somerset on the 8th, and proceeded across the Arafura Sea to the Arú Islands, reaching Dobbo. on the island of Wamma, on the 16th. We found no depth in the Arafura Sea greater than 50 fathoms, and the average depth was from 25 to 30 fathoms. The bottom was a greenish mud, due apparently to a great degree to the deposit from the great rivers of New Guinea and the rivers falling into the Gulf of Carpentaria.

Animal life was not abundant. Many of the animals seemed dwarfed, and the fauna had somewhat the character of that of a harbour or estuary. The specific gravity of the surface-water was unusually low, falling on the 23rd, off Dobbo Harbour, to 1.02505, the temperature reduced to 15°·5 C., distilled water at 4° C. = 1.

After spending a few days shooting Paradise-birds and getting an idea of the natural history of the island of Wokaw, we left Dobbo on the 23rd and proceeded to Ké Doulan, the principal village in the Ké group. We then went on to the island of Banda, where we remained a couple of days, and thence to Amboina, which we reached on the 4th of October.

On the 26th of September, after leaving the Ké Islands, we sounded and trawled in 129 fathoms. The trawl brought up a wonderful assemblage of things, including, with a large number of Mollusca, Crustacea, and Echinoderms of more ordinary forms, several fine examples of undescribed hexactinellid sponges, and several very perfect specimens of two new species of *Pentacrinus*. Temperature-soundings were taken on the 28th of September and on the 3rd of October, at depths of 2800 and 1420 fathoms respectively; and on both occasions the minimum temperature (3° C.) was reached at a depth of 900 fathoms, indicating that the lowest part of a barrier inclosing the Banda Sea, bounded by Taliabo, Buru, and Ceram on the north, the Aru Islands on the east, Timor and the Salvatty Islands on the south, and Celebes and the shoals of the Flores Sea on the west, is 900 fathoms beneath the surface.

From Amboina we went to Ternate, and thence across the Molucca passage into the Celebes Sea, by the passage between Bejaren Island and the north-east point of Celebes. On the 13th, we trawled and took serial temperatures near Great Tawallie Island. The trawl brought up several specimens of a very elegant stalked halichondroid sponge new to science, and the thermometer gave temperatures sinking normally to a bottom-temperature of 2°·04 C. On the following day we sounded in 1200 fathoms, with again a normal bottom-temperature of 1°·9 C. It seems, therefore, that the Molucca passage communicates freely with the outer ocean; it does so at all events to the depth of 1200 fathoms, and most probably to the bottom, if it include greater depths.

In the Celebes Sea we had two deep soundings—on the 20th, to 2150 fathoms, and on the 22nd, to 2600 fathoms. On both occasions serial temperature-soundings were taken, and on both the minimum temperature of 3°·7 C. (38°·7 F.) was reached at 700 fathoms. A passage of this depth into the Celebes Sea is therefore indicated, very probably from the Molucca passage. This temperature corresponds almost exactly with that taken by Captain Chimmo in the same area. We trawled on the 20th; and although the number of specimens procured was not large, they were sufficient to give evidence of the presence of the usual deep-sea fauna.

We reached Zamboanga on the 23rd, and on the 26th we passed into the Sulu Sea and trawled at a depth of 102 fathoms. On the 27th we sounded to 2550 fathoms, and took a serial temperature-sounding. A minimum temperature of  $10^{\circ}$  C. was found at 400 fathoms; so that the Sulu Sea must be regarded as the fourth of this singular succession of basins, cut off by barriers of varying height from communication with the ocean. This observation in the main confirmed those of Captain Chimmo in the same locality. The minimum temperature reached was the same in both, but we appear to have found it at a somewhat higher level.

We arrived at Ilo Ilo on the 28th, and proceeded by the eastern passage to Manilla, which we reached on the 4th of November.

The collections have been packed and catalogued in the usual way, and will be sent home from Hong Kong. We have had an opportunity during this cruise of making a very large number of observations of great interest. I believe I may say that the departments under my charge are going on in a very satisfactory way.

*February 11, 1875.*

JOSEPH DALTON HOOKER, C.B., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "On the Structure and Development of *Myriothela*."

By Prof. ALLMAN, F.R.S. Received February 5, 1875.

(Abstract.)

The *endoderm* of the body is composed of numerous layers of large spherical cells composed of clear protoplasm, enclosing a nucleus with some brown granules and refringent corpuscles. Externally it is continued in an altered form into the tentacles, while internally it forms long thick villus-like processes which project into the cavity of the body. Towards the free ends of these processes there are abundantly developed among the large clearer cells, smaller, easily isolated spherical cells, filled with opaque brown granules. Where the endoderm passes into the tentacles it loses its large clear-celled condition, and consists of small round cells, so loaded with opaque granules that the axis of the tentacle appears nearly white under reflected light.

The free surface of the endoderm carries, at intervals, long, very slender, sluggishly vibrating cilia, and is overlaid by a thin layer of homogeneous protoplasm, which on the villus-like processes becomes especially distinct,